

# NUCLEONICA: A WEB PORTAL FOR THE NUCLEAR SCIENCES

J. MAGILL

*European Commission, Joint Research Centre,  
Institute for Transuranium Elements, Postfach 2340, 76125 Karlsruhe, Germany*

## ABSTRACT

NUCLEONICA ([www.nucleonica.net](http://www.nucleonica.net)) is a new nuclear science web portal from the European Commission's Joint Research Centre. The portal provides a customisable, integrated environment and collaboration platform for the nuclear sciences using the latest internet "Web 2.0" technology. NUCLEONICA is aimed at professionals, academics and students working in fields as diverse as the life and earth sciences, and the more traditional disciplines such as nuclear power, health physics and radiation protection, nuclear and radio-chemistry, and astrophysics. It is also used as a knowledge management tool to preserve nuclear knowledge built up over many decades by creating modern web-based versions of so-called "legacy" computer codes. All NUCLEONICA's web applications are browser and operating system independent and can be accessed by a variety of mobile devices.

## 1. Introduction

Education, training and knowledge management in the nuclear field require the renaissance of sophisticated computational skills and tools which support recent developments on issues such as energy security and protection of the environment, advanced nuclear fuel cycles, qualitative and quantitative analyses of future nuclear power growth scenarios etc. The new nuclear science web portal NUCLEONICA contributes to this skill renaissance by offering many features which encompass the knowledge of generations of nuclear scientists.

NUCLEONICA is the latest development in a family of information systems for the nuclear science community. From the software technical point of view the history began with Nuclides 2000 [1] (a classical client side database application), developed further to Nuclides.net which was a combination of local client side database connected with web-based application modules. The most recent member of the family, NUCLEONICA [2], is fully web-based requiring, on the client side, only a web browser and internet access [3]. The NUCLEONICA portal (Fig 1) consists of four main "Centres" (Fig 2): Data Centre, Application Centre, Knowledge Centre, and Networking Centre.

## 2. Data Centre

Nuclear data can be accessed through online interactive nuclide charts [4] (based on decay modes, half-lives, binding energy, spin, parity, etc.), reference data (datasheets, derived data, cross sections, spectral data, fission yields, etc.) and searchable databases for internationally evaluated nuclear data. The NUCLEONICA database [1], which is based on the Joint Evaluated Fission and Fusion (JEFF3.1) radioactive decay datafile, contains decay data on 3896 nuclides in ground and isomeric states. In addition, spectral data with a total of approximately 54000 energies and emission probabilities is available. Additional databases include the 8<sup>th</sup> Table of Isotopes, prompt gamma neutron activation data, and effective dose coefficients.



Fig 1. NUCLEONICA nuclear science portal.

### 3. Applications Centre

NUCLEONICA applications are designed to be user friendly, intuitive, and require a minimum of learning time. These powerful applications, which form the “backbone” of the nuclear science portal, can be used by professionals and students for everyday calculations. For advanced users, NUCLEONICA provides a more “hands-on” approach with its advanced scripting interface [5].

The application modules include radioactive decay, dosimetry & shielding [6], fission yields, transport and packaging, library creation for spectroscopy, nuclide mixtures, webGraphics. Recently added applications include a range and stopping power module for charged particle interaction with matter (collaboration with Ondokuz Mayıs University) [7] and a radiological dispersion module for collective dose estimates following a radiological dispersion event (restricted access). Currently a new gamma spectrum simulator for a wide range of NaI and HPGe detectors is under development [8].

Through a collaboration between the Karlsruhe Research Centre and the Institute for Transuranium Elements, a web-based version of KORIGEN called webKORIGEN [9] has been developed for use in NUCLEONICA. For users, webKORIGEN overcomes the necessity of installation, input preparation and processing, compilation and debugging by offering an intuitive user-friendly web-based application – ideal for training purposes. With webKORIGEN, the user can concentrate on science rather than on the technicalities of large Fortran computer codes. WebKORIGEN supports calculations for a set of standardized problems, trimmed to three major classes of nuclear plants: the thermal power plants deployed worldwide as Pressurized Water Reactors (PWR) and Boiling Water Reactors (BWR) and a future extension to the current industrial technology the European Fast Reactor (EFR). This is discussed in more detail in section 6 in the context of preservation of nuclear knowledge and as an example of the development of a web application from a legacy computer code.

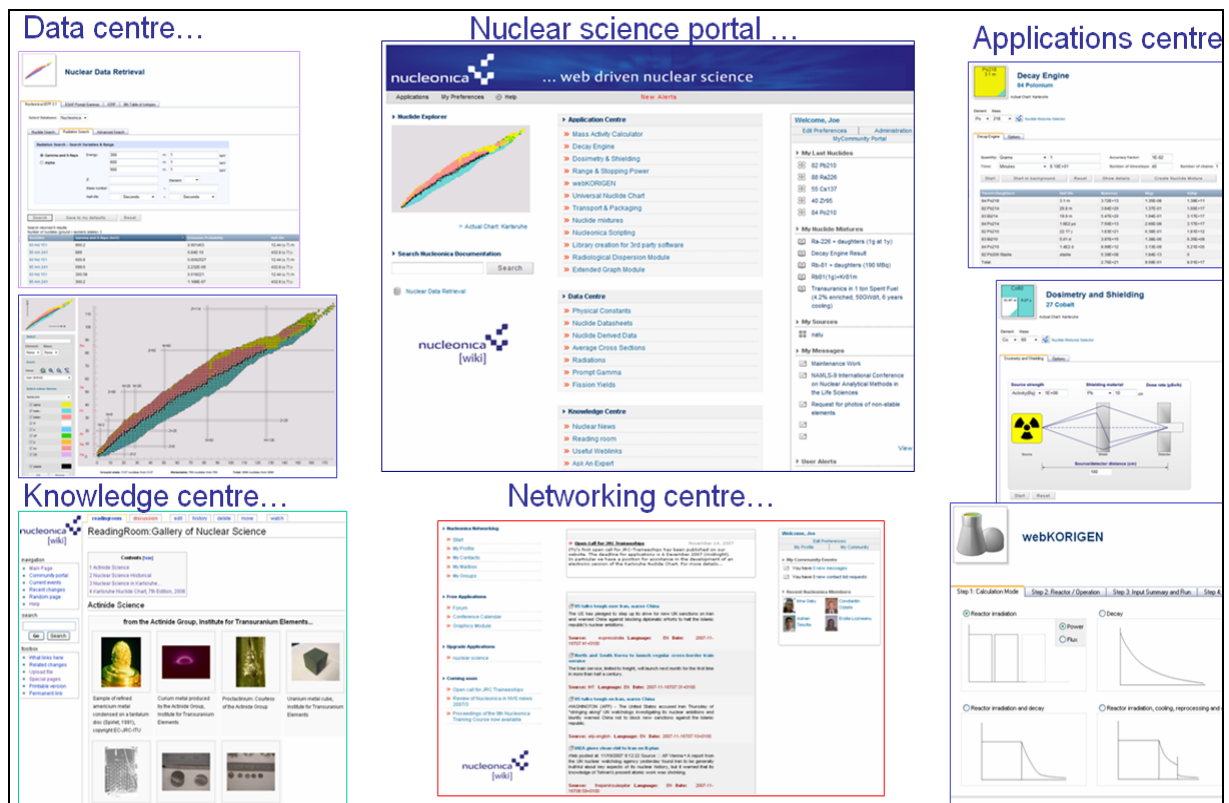


Fig 2. NUCLEONICA's main "Centres" for Data, Applications, Knowledge and Networking.

## 4. Knowledge Centre

The *Knowledge Centre*, or NucleonicaWiki [10], is the content management system (CMS) used for NUCLEONICA documentation. It is based on the same MediaWiki "engine" as used in Wikipedia. The NucleonicaWiki is used for online Help, ReadingRoom (for articles, and presentations), weblinks, element information, ask an expert Q & A etc.

The NucleonicaWiki is also used for training course organisation. To date, nine nuclear science training courses based on Nucleonica have taken place both at ITU and in external training centres. All training course announcements [11], agendas, full presentations, exercises, case studies, photo galleries etc., are available online in the NucleonicaWiki. NUCLEONICA training courses introduce the basic concepts of nuclear science and technology and are suitable for participants from the nuclear industry, nuclear research organizations, universities, regulatory authorities etc. Lectures are followed by "hands-on" case studies on the use of the NUCLEONICA web-based applications.

In addition to the above described nuclear science training courses, in 2008 we plan to initiate a number of short-stay training activities on NUCLEONICA at ITU. These short-stay training courses will provide PhD students, research fellows and trainees with a more extensive training in the use of NUCLEONICA through "mini-projects". Calls for proposals for such "mini-projects" will be announced on the NUCLEONICA website.

## 5. Networking Centre

The *Networking Centre* allows users to stay in contact with colleagues from workshops or conferences, meet scientists from similar areas of interest and build up an international contact list. The users can represent themselves (personal page) and their Institute/Organisation in the international science community. The nuclear news aggregation

service provides latest news and information on nuclear issues - the JRC's web crawlers scan hundreds of newspapers every few minutes.

NUCLEONICA's Conference Calendar can be used to enter information on forthcoming events, meetings, conferences etc. The user can decide if he wishes to share this information with other users. In this way a user-generated calendar of events is generated. Alternatively, the user can decide to keep the information in his personal diary.

## 6. Preservation of Nuclear Knowledge: Web-based Fuel Cycle Calculations with webKORIGEN

WebKORIGEN is a web-based user-friendly version of the KORIGEN code. KORIGEN, developed in the Karlsruhe Research Centre, constitutes a standalone package supporting the fuel depletion, reprocessing, and decay calculations. KORIGEN, originating from the ORNL ORIGIN code, is used in the German nuclear industry and by German licensing authorities for application to German light-water reactors. It enables reliable assessments of decay energy release from actinides, fission products and activated impurities in irradiated fuel and is routinely applied for purposes related to the safe handling, reprocessing and storage of spent fuel.

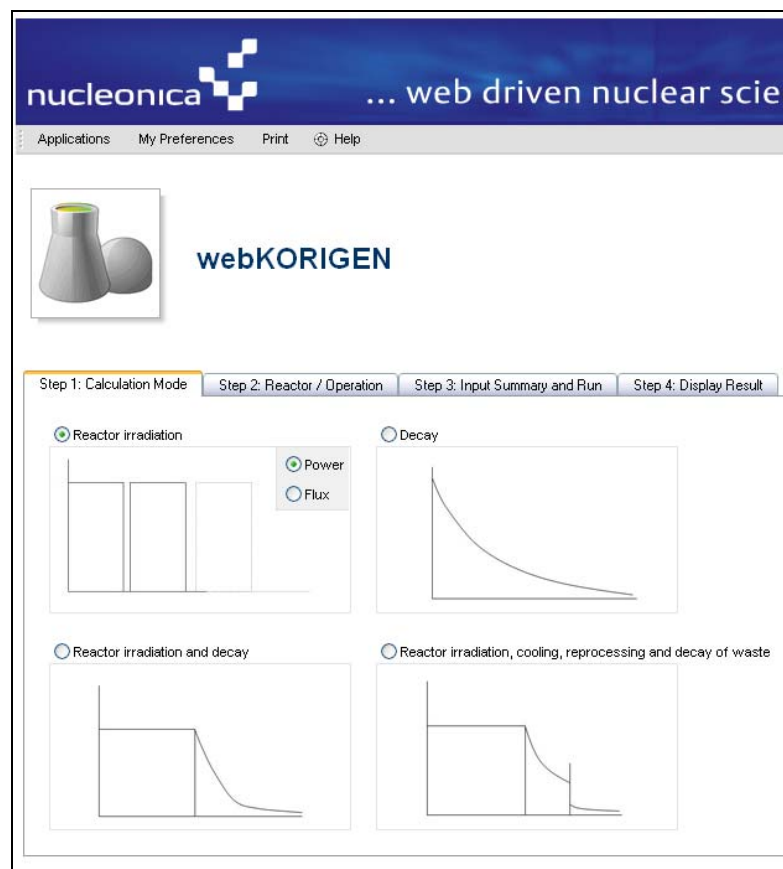


Fig 3. The webKORIGEN interface for fuel cycle calculations in NUCLEONICA.

By using webKORIGEN, advanced performance-based assessments of selected integral nuclear fuel cycle (NFC) characteristics can be done. It is applicable to both industrially practised, current and future advanced NFCs implementing the partitioning and transmutation (P&T) processes. The fuel cycle options in webKORIGEN cover “once-through” uranium-oxide NFC and “conventional reprocessing” NFC, the latter based on plutonium separation and single recycling in the form of uranium-plutonium mixed-oxide fuel. The webKORIGEN depletion engine uses facility data for thermal and fast systems; among them

the Pressurized and Boiling Water Reactors, and the European Fast Reactor. WebKORIGEN belongs to the isotopic summation codes which explicitly calculate, for a large set of isotopes, time dependent mass concentrations, radioactivities, decay heat and radiotoxicities of the nuclear material irradiated in a reactor core. Thus for the depletion calculations the complete nuclear databases must be supplied and managed. These data, prepared in advance, are transferred on demand to webKORIGEN from linked dedicated libraries. Their accuracy, benchmarked with experiments, warrants the reliable performance of the code.

## 7. Conclusions

NUCLEONICA is a web portal specifically dedicated to education, training and knowledge management in the nuclear sciences. In addition to providing internationally evaluated nuclear data, the portal provides access to a variety of nuclear science applications ranging from dosimetry and shielding to detailed fuel cycle calculations. NUCLEONICA's networking features allow users to stay in contact with colleagues, meet scientists with similar interests and build up an international contact list. The NucleonicaWiki provides a powerful content management system for online Help, ReadingRoom (for articles, and presentations), weblinks, element information, "ask an expert", etc., and in addition for information on the Karlsruhe Nuclide Chart [12].

With NUCLEONICA, there is no need to install software - all data and software is server-based. The development team takes care of maintaining the datasets and software and can add user options in response to customer demand. Further Information on registration [13] is available on the NucleonicaWiki.

## 8. References

- [1] For a brief history of NUCLEONICA see:  
[http://www.nucleonica.net:81/wiki/index.php/Help:Nucleonica\\_Database](http://www.nucleonica.net:81/wiki/index.php/Help:Nucleonica_Database)
- [2] J. Magill et al., NUCLEONICA: A Nuclear Science Portal, ENS News, Issue No.17 Summer (July 2007), see [www.euronuclear.org/e-news/e-news-17/nucleonica.htm](http://www.euronuclear.org/e-news/e-news-17/nucleonica.htm)
- [3] C. Grammes, C. Lambert, H. Fries, NUCLEONICA – Software Design Patterns, this conference.
- [4] J. Magill and J. Galy, Radioactivity Radionuclides Radiation, Springer Verlag, 2005.
- [5] R. Dreher, J. Magill, A. Berlizov, NUCLEONICA Scripting, this conference.
- [6] J. Galy and J. Magill, Interactive, Web-based Dosimetry and Shielding Calculations with NUCLEONICA, this conference.
- [7] M. Tufan, J. Magill, J. Galy, Range and Stopping Power Calculations in NUCLEONICA , this conference.
- [8] A. Berlizov and J. Magill, An Interactive Web Accessible Gamma Spectrum Simulator, this conference.
- [9] A. Schwenk-Ferrero et al., webKORIGEN: Web-based Fuel Cycle Calculations within NUCLEONICA, see <http://www.nucleonica.net:81/wiki/index.php/Help:WebKORIGEN>
- [10] NucleonicaWiki: see [www.nucleonica.net:81/wiki/index.php/Special:Allpages/Help](http://www.nucleonica.net:81/wiki/index.php/Special:Allpages/Help):
- [11] NUCLEONICA Training Courses, see  
[www.nucleonica.net:81/wiki/index.php/Help:Training\\_Course\\_Announcements](http://www.nucleonica.net:81/wiki/index.php/Help:Training_Course_Announcements)
- [12] J. Magill, Ch. Normand, G. Pfennig, J. Galy, R. Dreher, The Karlsruhe NuclideChart: An Educational Tool for the Nuclear Science Community, this conference.  
See also <http://www.karlsruhenuclidechart.net> .
- [13] Register as a NUCLEONICA user, see:  
[http://www.nucleonica.net:81/wiki/index.php/Help:Register\\_as\\_a\\_Nucleonica\\_User](http://www.nucleonica.net:81/wiki/index.php/Help:Register_as_a_Nucleonica_User)